

## DEVELOPMENT OF MULTIPURPOSE PUNCHING AND CUTTING MACHINES

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### ABSTRACT

Two models of multipurpose machine viz. sitting model and standing model to punch a hole in tender coconut, to split a tender coconut after drinking inside water, to dehusk the ripened coconut, cutting a sugarcane bud chip, to cut raw mango into small pieces for pickle preparation and for bottle corking were developed by Dr. D. Y. Patil College of Agricultural Engineering and Technology, Talsande, Kolhapur (M. S.) India in December, 2014. These two models were studied for their performance and compared with traditional tools/machines. The sitting model of multipurpose machine was able to perform six operations viz. tender coconut punching, tender coconut cutting or splitting matured coconut dehusking, raw mango cutting, bottle corking and sugarcane set cutting. This model performed best in punching of tender coconuts (69 coconuts/hr) and dehusking of matured coconuts (75 coconuts/hr) than other purposes of the machine when compared with standing model and traditional methods. Standing model of multipurpose machine was able to perform all operations that sitting model can perform except matured coconut dehusking and bottle corking. Standing model performed best in cutting or splitting of tender coconuts (102 coconuts/hr) and raw mangoes cutting (21.22 kg/hr) than other purposes of the machine when compared with sitting model and traditional method. Both the models of multipurpose machine have shown poor performance in sugarcane set cutting when compared with traditional cutter.

**KEYWORDS:** Multipurpose Machine, Tender Coconut Punching, Dehusking & Bottle Corking etc

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### INTRODUCTION

Water from tender coconut is a common refreshing drink and has been used as an excellent isotonic in several tropical countries. It is not only a thirst-quenching liquid, but also a mineral drink, which is beneficial to human health (Poduval *et al.*, 1998).

A common problem that many people are facing in a developing country like India is punching and splitting the tender coconut. Present tools and trends used are unsafe as well as the risk of injury is high. From past years the tender coconut is being opened and cut by completely manual effort by using a hard knife. The tools used are unsafe, messy and need skill and training. Some machines for paring coconut are available, but until now no household tool exists to punch hole in tender coconut and split it open safely. (T. Roshni *et.al.* 2009).

For household dehusking small machine is used in which the coconut is pierced on the wedge like blades and then the foot pedal is pressed to split open and separate a portion of the husk. The operation is repeated 3 to 4 times until complete dehusking is done. These kinds of machines are more popular for household deshuking of

coconut.

Mango pickles made up of raw mango, which is an excellent source of vitamin C. The machines have high capacity saves labour up to 90% and gives maximum output in less time. Small raw mango cutting tool is needed for household use where pickle making not a year round business.

In the conventional method, 2 to 3 budded sugarcane sets are used for planting. In SSI, single budded chips, carefully removed from healthy canes are used for raising nursery. The selected buds are placed in trays filled with coco-pith (coconut coir waste) to raise the seedlings. Traditional hand-held cutting tools used for bud chipping requires more stress which cause wastage, and damage with slanting cuts, and are incapable of dealing with hard plant gratings. This necessitates a small machine which can be used by individual farmer and suitable for making proper buds.

Generally, for domestic use manually operated bottle corking machine is used for cork the crown caps on mouth of glass bottles. It has corking shaft for setting of crown cap compression spring for regain the original position of corking shaft. Place the bottle to be corked on platform under shaft and press down the handle, cap will corked on its mouth.

## MATERIAL AND METHODS

The details of components of both the developed models of multipurpose machines and the machines used for comparison are explained as under

### Standing Model

This model was able to perform tender coconut punching, mango cutting, bottle corking, and sugarcane bud chipping operation in standing posture of operator whereas tender coconut splitting or cutting can be done in sitting or bending posture. This model does not have coconut dehusking tool (Figure 1 A).

### Sitting Model

This model was able to perform all the operations that a standing model can do. All these operations can be done in sitting posture .only difference in standing and sitting model is that, sitting model can perform tender coconut cutting or splitting by using separate tool (Figure 1 B).



a) Standing Model



B) Sitting Model

**Figure 1: Multipurpose Punching and Cutting Machines Developed**

### Details of Components Used in Both Models

#### Punching Tool

Dimensions of punching tool were selected on the basis of average size of tender coconut (depth of shell of coconut from outer surface) and diameter of straw used for drinking coconut water. Average depth of shell of coconut from outer surface was found between 70 to 100 mm and the diameter of straw generally and radially available was 6 to 8 mm therefore a punch of 160 mm length and 12 mm diameter was selected. One end of tool was threaded up to 25 mm length to fix it securely in the holder and other end was pointed up to 30 mm length. As this tool had to work in contact with tender coconut water, stainless steel material was used to prevent corrosion (Figure 2).



**Figure 2: Tender Coconut Punching Tool**

#### Cutting Tools for Cutting Raw Mango and Sugarcane Sets

A rectangular wedge shaped tool of 110 mm×40 mm size with 6 mm thickness with sharp edge was used for mango cutting and sugarcane set cutting. A 125 mm long and 12 mm diameter round rod with one end threaded was welded to the blade at centre. Threaded end can be fixed in a holder to hold it in position securely. A check nut was used to maintain straight alignment of blade (Figure 3).

A wooden plank was used to achieve cutting of sugarcane and mango. It was made movable and can be fitted in as and when needed. In case of standing model, it was fixed in the frame just below the tool holding rod with help of locking strips. In case of sitting model it was a separate arrangement consisting a square frame with 4 legs of 200 mm height and is bolted to the main base frame.



**Figure 3: Mango Cutting Tool**

### Bottle Corking Tool

It had corking shaft for setting of crown cap compression spring for regain the original position of corking haft. It has two parts, one is upper part or connecting part and had diameter of 25 mm, lower part had outer diameter of 50 mm and inner diameter of 25 mm, as usual mouths of glass bottles are of 25 mm (Figure 4).



**Figure 4: Bottle corking tool**

### Coconut Cutting Tool

In sitting model it was provided separately as a frame of size 750 mm×25 mm fabricated in 25 mm square pipe and in case of standing model it is provided at lower portion of machine. The cutting blade in both the models was sharpened at one edge and it was 700 mm long, 80 mm wide with 8 mm thickness. Two 50x5mm size MS flat strips were provided on the cutting platform to support and hold the tender coconut in position (Figure 5 A and B)



**A) Standing Model**



**B) Sitting Model**

**Figure 5: Coconut Cutting Tool**

### Coconut Dehusking Tool

It had knife jaw formed by one rigid blade and another movable blade with handle to dehusk the coconut. It was provided only on sitting model.

### Main Support Rod

Holding rod was attached to base frame by nut bolt. Tender coconut holding ring, stopping fork, handle were attached to the holding rod. It was of mild steel with 25 mm diameter and 850 mm height. Holder rod was fitted into holding frame.

### Tool Holding Rod

It was used to connect the handle and operating tool. It had internal threads at its lower end to attach the punching tool or cutting tool or bottle corking tool. It had 25 mm outer diameter, 500 mm length and made up of mild steel.

### Spring

It was used to regain the operating position of machine by pushing tool holding rod in its original position after completing the task. Compression spring of 30 mm inner diameter and 3 mm wire diameter was used for this purpose. It was fitted around the tool holding rod. The solid length of spring was 75 mm.

### Holder Frame

Holder frame was used to guide the tool holding rod. It was fitted on main support rod by nut and bolts. It is of mild steel with 190 mm long and 150 mm height. Holder frame can be adjusted for its height by adjusting its position on main support rod.

### Machines Selected for Comparison

#### Cutting Blade for Tender Coconut Opening and Cutting

A sharp sickle was used for the slicing the tender coconuts and to open it. The tool used is shown in Figure 6



**Figure 6: Cutting Blade for Tender Coconut Opening and Cutting**

### Dehusking Tool

A widely tool to dehusk the coconut was used. A tool consisted of two blades one is fixed to the upright column and the other was movable. The movable blade was attached to the handle. As force is applied on the handle the jaw rotates which helps in dehusking. While dehusking the coconut was impaled onto the blades in closed position, and then handle



was lifted up to dehusk. Such a repetition or two to three times dehusked the coconut completely. (Figure 7).



**Figure 7: Dehusking tool**

### **Sugarcane Bud Chipping Tool**

Sugarcane bud chipper is used for removing the bud from the node of the whole sugarcane set. A simple hand operated cutter was used for this purpose (Figure 8).



**Figure 8: Sugarcane Bud Chipping Tool**

### **Raw Mango Cutter**

Mango cutter is used for cutting the raw mango. It consisted of sharp blade with handle. The tool is operated by one hand and the mango to be cut with the other hand. (Figure 9)



**Figure 9: Mango Cutter**

### Bottle Corking Machine

Bottle corking machine is used for sealing bottle straight cork. It is operated by manually to send the bottle below sealing head. The press head will press the cork in to the bottle, then product is finished. (Figure 10)



Figure 10: Bottle Corking Machine

### Performance Parameters Selected For Evaluation

#### Punching Rate

Punching rate of multipurpose machine was calculated by recording the time required to punch the 50 coconuts and calculated as:

$$\text{Punching rate} = \frac{\text{no.of coconuts punched}}{\text{time(hr.)}}$$

#### Cutting Rate

Cutting rate of tender coconut was calculated by recording total time required for cutting/splitting the 50 coconuts. In case of raw mangoes cutting rate was calculated by recording time required for cutting the 50 mangoes in 8 parts. The rate of sugarcane set cutting was calculated from time required for cutting of 10 sugarcane sets with average diameter of 27.6 mm having 20 to 22 buds. The number of buds (sets) cut in unit time was taken as sugarcane cutting rate.

$$\text{Cutting rate} = \frac{\text{no.of coconuts or raw mangoes or number of buds (sets) cut}}{\text{time(hr.)}}$$

#### Dehusking Rate

Dehusking rate of traditional coconut dehusker and sitting model and MPPM was calculated from time required to dehusk 50 coconuts and calculated as:

$$\text{dehusking rate} = \frac{\text{no.of coconuts completely dehusked}}{\text{time(hr.)}}$$

### Bottle Corking Rate

The time required to cork 50 bottles was recorded and bottle corking rate was calculated as:

$$\text{bottle corking rate} = \frac{\text{no.of bottles corked}}{\text{time(hr.)}}$$

## RESULTS AND DISCUSSIONS

### Punching Rate of Tender Coconuts

An average punching rate of tender coconuts observed with sitting model was 21.05 per cent and 13.11 percent higher than standing and traditional method of opening the tender coconut. Higher Punching rate in case of sitting model of multipurpose machine was found due to less pain and stress to operator and use of stopping fork that helped to increase the rate of punching. (Figure 11).

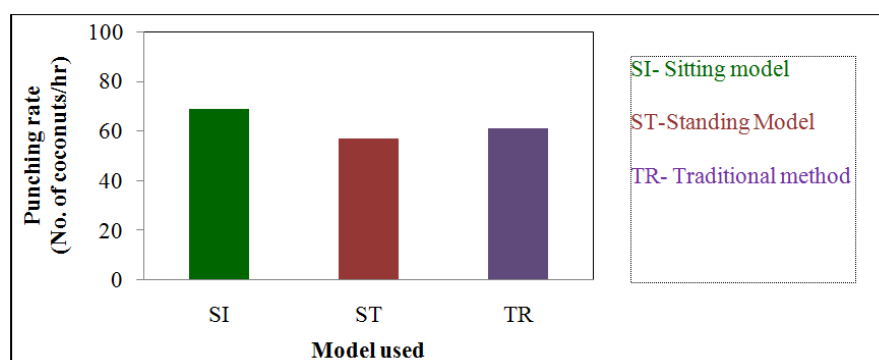


Figure 11: Punching Rate of Tender Coconuts Recorded with Different Models.

### Cutting Rate of Tender Coconut

An average tender coconut cutting rate of standing model of multipurpose machine was 37.83 per cent and 64.51 per cent more than sitting model and traditional method. The higher rate of cutting of tender coconut observed with standing model was due to more stability of machine during the cutting process than sitting model and traditional method which increased the capacity to cut the tender coconuts. (Figure 12).

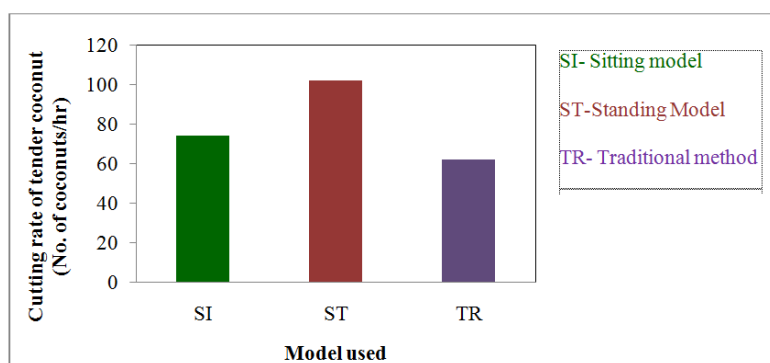


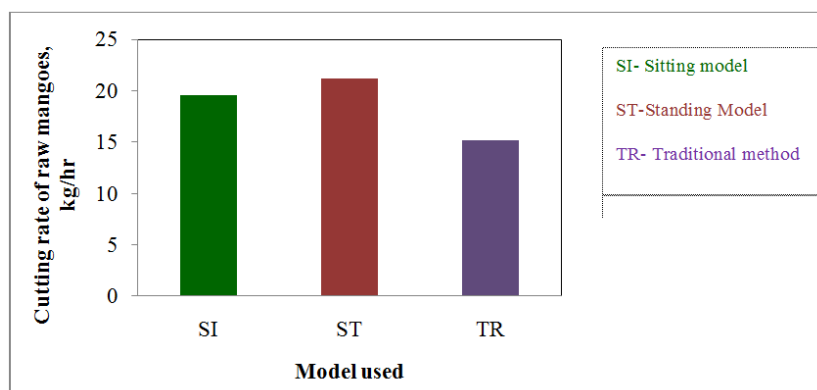
Figure 12: Cutting Rate of Tender Coconuts Recorded with Different Models

### Cutting Rate of Raw Mangoes

An average raw mango cutting rate of standing model of multipurpose machine was 8.26 per cent and 40.15 per cent more than sitting model of multipurpose machine and traditional mango cutting blade.



Highest cutting rate of raw mangoes observed with standing model of multipurpose machine was might be due most comfortable working posture than other two models. At the same time traditional cutting blade required to be operated in sitting posture by holding the frame with leg which lead to more stress in legs hence least cutting rate was recorded. (Figure 13).



**Figure 13: Cutting Rate of Raw Mangoes Recorded With Different Models.**

### Dehusking Rate

Dehusking of matured coconut was not provided on standing model hence dehusking rate was recorded and compared among sitting model and traditional dehusker.

An average dehusking rate observed with sitting model of multipurpose machine was 53 per cent more than traditional coconut dehusker shown in Table 1. This may be due to more pain in holding the machine by foot and bending posture with traditional coconut dehusker, whereas in case of sitting model, dehusking can be done by sitting on a stool, used as raw mango cutting platform and did not required holding by legs to keep the dehusking tool firm.

**Table 1: Dehusking Rate of Matured Coconuts**

Batch No.	Dehusking Rate (coconuts/Hr)		
	SI Model	ST Model	TR Method
I	72	NA	54
II	73	NA	48
III	80	NA	46
<b>AVE.</b>	<b>75</b>	<b>NA</b>	<b>49</b>

SI = Sitting, ST= Standing TR= Traditional NA= Not available

### Bottle Corking Rate

The bottle corking facility was not available in standing model of multipurpose machine hence, bottle corking rate was recorded and compared among sitting model and traditional dehusker. Bottle corking rate of sitting model of multipurpose machine and existing traditional machine observed was found at par as shown in Table 2.

Table 2: Bottle Corking Rate

Batch no.	Dehusking Rate (coconuts/hr)		
	SI Model	ST Model	TR Method
I	78	NA	75
II	81	NA	84
III	79	NA	80
AVE.	79.33	NA	80

SI = Sitting, ST= Standing TR= Traditional NA= Not available

### Rate of Sugarcane Set Cutting

The sugarcane set cutting rate observed with traditional method was 30.28 percent and 10.67 percent more than standing model and sitting model of multipurpose machine. The lower rate of sugarcane set cutting observed with both the models was due to more efforts required to hold the entire sugarcane set horizontal (for cutting) with only one hand and operating handle with other hand required more time for set cutting. (figure 14).

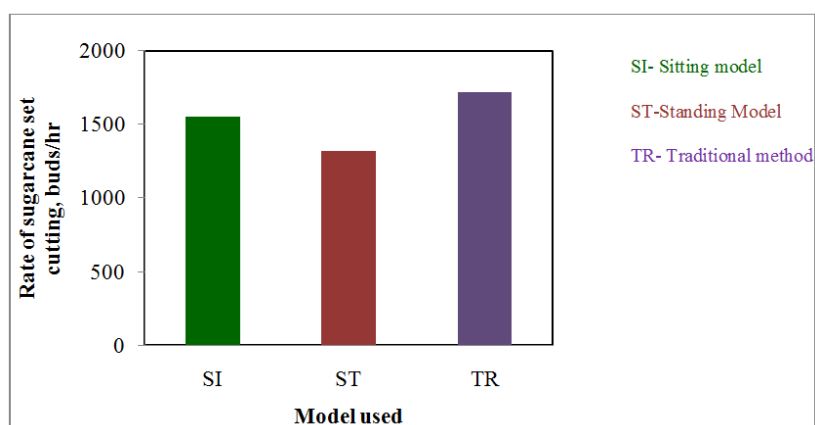


Figure 14: Rate of Sugarcane Set Cutting Recorded With Different Models

### CONCLUSIONS

- The sitting model of multipurpose machine was able to perform six operations viz. tender coconut punching, tender coconut cutting or splitting matured coconut dehusking, raw mango cutting, bottle corking and sugarcane set cutting. This model performed best in punching of tender coconuts and dehusking of matured coconuts than other purposes of the machine when compared with standing model and traditional method.
- Standing model of multipurpose machine was able to perform all operations that sitting model can perform except matured coconut dehusking and bottle corking. This model performed best in cutting or splitting of tender coconuts and raw mangoes cutting than other purposes of the machine when compared with sitting model and traditional method.
- Both the models of multipurpose machine had shown poor performance in sugarcane set cutting when compared with traditional cutter.
- Bottle corking rate observed with sitting model of multipurpose machine was almost equal to the existing traditional bottle corking machine.

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